

# *Archaeological Paleobiogeography in the Russian Far East: The Kuril Islands and Sakhalin in Comparative Perspective*



BEN FITZHUGH, SCOTTY MOORE, CHRIS LOCKWOOD,  
AND CRISTIE BOONE

ISLANDS ARE UNIQUE LOCATIONS FOR THE DEVELOPMENT OF SYSTEMATIC comparative studies of evolutionary and adaptive behavior, a point that has been long appreciated in the insular Pacific (Bellwood 1989; Kirch 1988; Terrell 1977, 1997). In this article, we present biogeographical analyses of lithic artifacts and archaeofauna from the Kuril Island chain and southern Sakhalin Island in the Sea of Okhotsk. We seek to demonstrate the utility of the theory of island biogeography in the systematic comparison of island-based archaeological assemblages. Through this process, we advance new insights into the dynamics of insular Northeast Asian prehistory.

MacArthur and Wilson (1967) introduced the theory of island biogeography in a landmark volume that stimulated decades of productive biological field study in relatively bounded environments (Whittaker 1998) but little anthropological or archaeological study (see Terrell 1977, 1997). According to island biogeography, species immigration and extinction rates should vary in relation to island isolation and size. Islands closer to source areas (mainland) should have higher rates of immigration compared to those farther from source areas. Similarly, smaller islands should have higher extinction rates compared to larger islands. Putting these principles together, large islands close to the mainland tend to have higher species diversity (richness) than other islands. Conversely, smaller islands farthest from sources tend to have the lowest species diversity, and by extension, the most vulnerable ecosystems. Small islands close to sources have high extinction rates but also high immigration rates, and so species populations are more likely sustained or replenished in these contexts (the "rescue effect": Adler and Wilson 1989; Brown and Kodric-Brown 1977; Hanski 1986).

These predictions are largely borne out in biological studies, and they have important implications for human colonists in island environments. Terrestrial-

Ben Fitzhugh is an assistant professor in the Department of Anthropology, University of Washington, Seattle; Scotty Moore and Chris Lockwood are graduate students in the Department of Anthropology, University of Washington, Seattle; and Cristie Boone is a graduate student in the Department of Anthropology, University of California-Santa Cruz.

based hunter-gatherers should take advantage of greater resource diversity and sustainability closer to mainland regions and on larger islands. Also, greater diversity will often mean a larger selection of prey species, some of which will be more profitable than others (see Faunal Analysis section for additional discussion of this point). Penetration of more remote and smaller islands implies greater ability to adapt flexibly to resource scarcity and vulnerability. As predators entering bounded ecosystems, hunter-gatherers can have marked impacts on indigenous species—effects that could have long-term implications for their own persistence in these environments. The ability of humans to develop unique adaptive strategies to overcome the hazards of insularity, and the dynamic interaction of humans and the environment on islands, makes the study of human island biogeography and historical ecology particularly interesting.

In addition to the technological capability to travel to remote locations over water, two contrasting subsistence adaptations have enabled humans to successfully colonize remote and small islands at various times in the Holocene, despite the impacts human occupation can easily have on insular terrestrial biotas. These adaptations include (1) technologies for hunting, fishing, and collecting marine resources and (2) the introduction of intensive food production (Fitzhugh and Hunt 1997; Kirch and Ellison 1994). Maritime subsistence adaptations reduce the ecological footprint of island colonists by transferring predation to species often better adapted to moving between islands and, to some extent, escaping localized harvesting depression and demographic extinction (see Yesner 1980). While less vulnerable to the effects of island insularity, migratory marine resources (marine mammals, fish, and sea birds) can become locally depleted or abandon accessible patch locations, thus creating difficulties for humans dependent upon them (Etnier 2002; Fitzhugh et al. 2002; Hildebrant and Jones 1992; Lyman 1995). Food producers often cause the most dramatic ecological changes on islands by introducing and encouraging domesticated plant and animal species over indigenous ones. Land modifications are also often more extreme with food production (e.g., field clearing, grazing) and can have significant long-term effects on the stability and productivity of the new landscape (see Amorosi et al. 1997; Burney 1997; Kirch 1997; McGovern 1990).

Human populations themselves are vulnerable to insularity, leaving them prone to demographic extinction where suitable marriage networks cannot be maintained (Wobst 1974). A prerequisite for successful colonization of insular environments then should be the capability to maintain social contacts with neighboring populations, at least until local populations build sufficiently (which is possible only on larger islands). Such networking also supports information sharing and a degree of adaptive flexibility to deal with unpredictable but localized environmental degradation.

In the analysis to follow, we consider the effects of relative insularity on the colonization of the Kuril Island chain by maritime hunter-gatherers. The Kurils are contrasted internally on the basis of relative isolation from mainland or more “mainland-like” environments at either end (Kamchatka Peninsula and Hokkaido, respectively; Fig. 1) and with the more “mainland-like” region of southern Sakhalin Island. This study focuses on lithic and zooarchaeological data collected during a four-week survey in 2000. Our primary goal in this article is to evaluate the potential of biogeographical theory to enhance our understanding of vari-

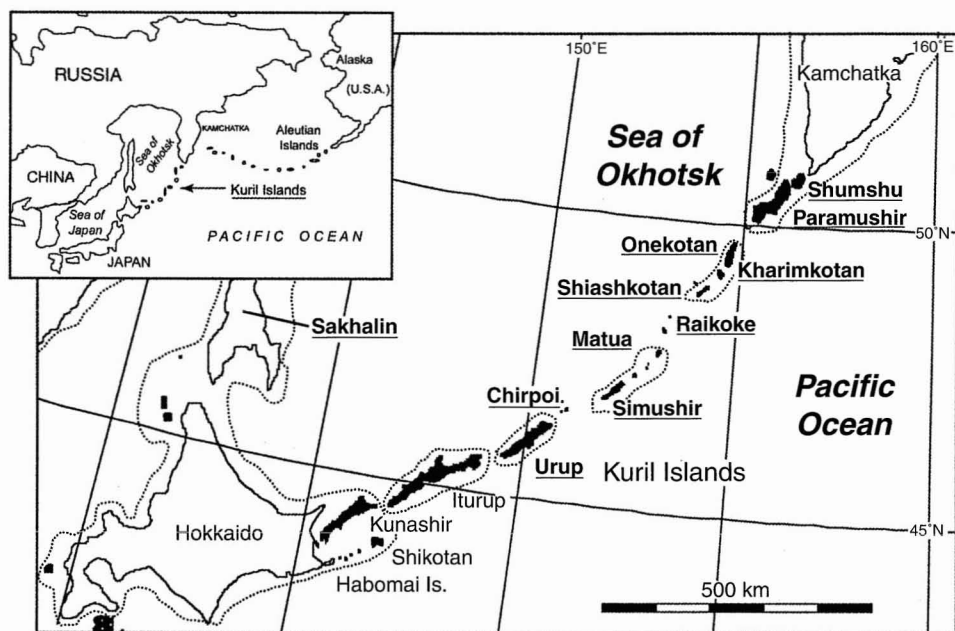


Fig. 1. The Kuril Archipelago and its position in the northwestern Pacific. Underlined names represent islands visited for archaeological survey during the 2000 season. Dashed line approximates Late Glacial Maximum coastlines.

ability in human adaptation to locations of differing degrees of insularity. The research reported here represents an initial attempt to refine and test simple hypotheses of hunter-gatherer settlement in remote island regions. In the future, we hope to expand this work to better capture temporal change and processes of human adaptation to insular settings and to better understand the reciprocal effects that hunter-gatherers can have on insular ecosystems.

#### THE KURIL ISLANDS AND SAKHALIN

The primary arc of the Kuril Islands is composed of approximately 32 islands stretching for 1200 km from the northeast corner of Hokkaido to the Kamchatka Peninsula (Fig. 1). A secondary arc of older islands projects a short distance into the Pacific from eastern Hokkaido paralleling Kunashir Island in the southern part of the main chain. Our concern in this article is limited to the primary arc and particularly the islands from Shumshu and Paramushir south to Urup. These islands derive from volcanic cones connected to the Kuril Trench Subduction Zone, where the Pacific oceanic plate subducts below the Eurasian continental plate. Many of the volcanoes that form these islands have been active in the Holocene (Gorshkov 1970; Ishizuka et al. 2001). Earthquakes and tsunamis are also common (Zayakin and Luchinina 1987).

Ecologically, the northern and central Kurils are dominated by subarctic tundra heath vegetation and a very limited terrestrial fauna (fox, vole). Today the southernmost islands, Kunashir and Iturup, are forested, and support a modest assem-

blage of fauna, including deer and bear. Our research did not enter this southern ecological province and was limited to the more subarctic islands. Winters in the Kurils are dominated by harsh storms and freezing temperatures. Modern land-fast ice extends from the northern Sea of Okhotsk south along the western edge of the Kamchatka Peninsula almost to the northern Kurils. In the past this could have extended farther south. Pack ice can extend south along the Kurils nearly to Hokkaido in cold winters. Summers are less stormy but characteristically foggy.

#### THE INTERNATIONAL KURIL ISLAND PROJECT 2000

We were fortunate to have an opportunity in summer 2000 to conduct a preliminary investigation of archaeological sites from the northern, central, and northernmost southern Kuril island groups and in southern Sakhalin. The data reported here were generated from a four-week reconnaissance of 11 sites from Shumshu Island in the north to Urup Island in the south and five sites around Aniva Bay and the western coast of southern Sakhalin Island (Fig. 1).

Because relatively little was known about the settlement history of the more insular central Kuril Islands, our survey focused on basic chronology building, site mapping, field testing, and sampling. The results of these efforts are published elsewhere (Fitzhugh et al. 2002), but relevant points are summarized here. In contrast to the southern island of Iturup, which has evidence for continuous occupation back to  $4220 \pm 160$  B.P.<sup>1</sup> (Zaitseva et al. 1993), our data suggest that the islands to the north of Iturup may have been occupied only from about 2500 years ago, beginning in the terminal Jomon or Epi-Jomon. Dates and diagnostic pottery of this time period are found from southern Urup, Chirpoi, and Matua Islands. It is unknown whether the earliest sites we found represent the initial pulse of human colonists to the central islands. Geological factors such as volcanic activity and/or variation in relative sea levels due to tectonic, isostatic, or eustatic processes could easily have affected earlier archaeological deposits, a contingency that we plan to investigate more fully in the future. In succession, the Kurils were occupied first by Epi-Jomon, Okhotsk, and then Ainu hunter-gatherers before they were swept into the currents of eighteenth- to twentieth-century international economic and geopolitical competition (Baba and Oka 1938; Befu and Chard 1964; Imamura 1996; Walker 2001; Yamaura and Ushiro 1999).

Years of detailed research in Hokkaido and Sakhalin reveal the basic details of southern Okhotsk sea prehistory (e.g., Golubev and Lavrov 1988; Imamura 1996; Vasil'evskii 1992, 1997; Vasil'evskii and Golubev 1976), which informs our efforts in the Kurils. In the Epi-Jomon period in Hokkaido and eventually the Kurils, descendants of the Jomon continued to hunt and gather from the first to the seventh centuries A.D. while rice agriculture was becoming the dominant economic activity to the south in Honshu (Kikuchi 1999). Epi-Jomon culture seems to have been more maritime oriented than its predecessors (A. Okada 1998; H. Okada 1998; Niimi 1994; Yamaura 1998). In southern Hokkaido, the Epi-Jomon culture is replaced by the Honshu-influenced Satsumon tradition in the sixth century A.D. (Yamaura and Ushiro 1999:44). In the fifth and sixth centuries A.D., Epi-Jomon is replaced in northern Hokkaido and in the Kurils by the intensely maritime Okhotsk tradition (Baba 1940; Yamaura and Ushiro 1999:43). Russian and Japanese scholars currently see the Okhotsk culture as a rapidly ex-



pandering population with roots in the lower Amur River and/or northern Sakhalin Island about A.D. 400–500 (Otaishi 1994; Yamaura and Ushiro 1999:44). The Okhotsk are known for their large villages composed of numerous large pentagonal pithouses, possession of domesticated pigs, developed sea mammal harpoon technology, defensive fortifications and distinctive appliquéd pottery styles (Befu and Chard 1964; Vasil'evskii and Golubev 1976). Their success was due in part to their effective maritime technology and their role in interregional trade between states in the Japanese archipelago and Manchuria. According to data from the International Kuril Island Project (Fitzhugh et al. 2002), the Okhotsk occupation of the Kurils was the most intensive period of human settlement in the history of the island chain. This occupation seems to have continued later in time in the Kurils than elsewhere and may support an Okhotsk role in the origins of the ethnohistorically and ethnographically known Ainu (see Watanabe 1972).

The Ainu occupied the region from Sakhalin and northern Hokkaido through the Kurils from about A.D. 1200–1300 into the twentieth century (Yamaura and Ushiro 1999:40, 45–46). In the Kurils they were fisher-hunter-gatherers who supplied furs and other products to Japanese merchants in exchange for Japanese commodities. Following the movement of Russian explorers and traders into Kamchatka and the northern Kurils in the early eighteenth century, Japan became more interested in expanding control over the Kurils and its inhabitants (Hasegawa 1998:19–27; Sasaki 1999:88). After 150 years of declining autonomy, imposed relocation programs, and high rates of disease-induced mortality, the remaining Kuril Ainu were forced to abandon the islands along with other Japanese residents following World War II (Hasegawa 1998:78; Kikuchi 1999:51). Even prior to the incursion of Russians and Japanese, the Ainu period is sparsely represented in our samples. We believe this finding indicates a smaller population density and perhaps a shift toward more trade-oriented use of the islands, rather than primarily subsistence pursuits, as was the case before (see Sasaki 1999). Tikhmenev (1978:173) reports an 1812 census of “sixty-seven inhabitants on all the Kuril Islands,” a population that might have been on the verge of demographic extinction if the estimates are accurate. Nevertheless, the Ainu appear still to have been year-round occupants of many of these islands at the time of Russian contact (W. Fitzhugh 1999; Krashenninnikov 1972).

Prior research in the Kuril Islands by Japanese and Russian researchers has focused largely on the southern and northern ends of the chain in the vicinity of modern settlements. This work was initiated in substantial measure by O. Baba's survey and excavation work in the southern Kurils (Baba 1934) and on Shumshu Island (Baba 1960) and was important in recognizing the distribution of the Okhotsk culture around the southern rim of the Sea of Okhotsk, from Sakhalin Island to the northern Kurils. Subsequent research has advanced our understanding of the cultural historical affiliations, chronology, and adaptations of Kuril inhabitants (Baba 1934, 1937, 1960; Chard 1960; Chubarova 1960; Golubev 1972; Kuzmin et al. 2002; Shubin 1977, 1990, 1994; Stashenko and Gladyshev 1977; Ushiro 1996; Yamada 1999; Yamada and Tezuka 1992; Zaitseva et al. 1993).

On the basis of evidence from the Japanese Jomon period, we can infer that maritime foraging capabilities developed gradually over a 5000-year period beginning at the end of the Pleistocene. Shellfish collection and fishing are evident

as early as the Initial Jomon period dating to 9000 B.P. (see Imamura 1996:57–63). These practices increased substantially in eastern Japan's Early Jomon period (H. Okada 1998:336). On Hokkaido, sea mammal hunting and net fishing are evident by the Early Jomon though toggling harpoon heads suggest that the Initial Jomon may also have been involved in marine mammal hunting (Yamaura 1998). Marine mammal hunting is thought to develop in the Primorye region of the Russian Far East by about 6000 B.P. (Yesner 1998). The earliest evidence for post-Pleistocene occupation on Sakhalin Island is approximately 7000 B.P. (Vasil'evskii 1995). This is similar to the earliest occupation date from the southern Kurils (Zaitseva et al. 1993). By 2500 B.P., when we have the earliest evidence of occupation in the central Kurils, coastal maritime hunting and fishing, including sea-mammal hunting, had been well established elsewhere in the Japanese archipelago and Russian Far East for millennia (e.g., Lebedintsev 1990, 1998; A. Okada 1998; H. Okada 1998; Yamaura 1998).

Collected during the International Kuril Island Project's (IKIP) 2000 expedition, the archaeological samples discussed in this paper come from a number of sites distributed throughout the northern and central Kurils as well as Sakhalin. Fitzhugh and colleagues (2002) have discussed details of the IKIP archaeological survey. In southern Sakhalin Island, we visited a number of previously investigated and reported sites in the Aniva Bay region to collect comparative samples. These sites include an early Neolithic site (Sadovniki 2:  $6740 \pm 150$  B.P., MAG-694; Vasil'evskii 1995, cited in Kuzmin et al. 1998) on the west coast, three Okhotsk period midden sites (Sosuya, Solov'yevko 1, and Lyutoga 1) and an Okhotsk/Ainu period fortification (Solov'yevko 2) in the Aniva Bay region. The site of Sosuya has been important for tracing Okhotsk origins to southern Sakhalin and ultimately the Amur River region (Vasil'evskii and Golubev 1976; Yamaura and Ushiro 1999:43). Our work on Sakhalin provides little new information on culture history, but important comparative data. Radiocarbon dates from our Sakhalin Island samples are reported in Table 1. A listing of dates for the Kuril Island sites are published in Fitzhugh et al. (2002).

#### ANALYSES

The analyses here consider the role of biogeographical isolation on stone tool technology (raw material access and distribution) and subsistence variability (archeofaunal richness and relative abundance). Lithic and faunal samples were collected during the IKIP 2000 field season. Because of the nature of this reconnaissance survey, these data are most suitable for geographical analyses and less so for a study of temporal change. Chronological resolution is poor or entirely unavailable from debitage collections; many are from surface contexts on multicomponent sites. The faunal samples are better constrained to time, but the number of samples large enough to include in this comparative analysis is too low to allow for meaningful diachronic comparisons. We expect to develop the temporal dimension through future work.

The general hypothesis under examination here is that geographic location and insularity affects raw material procurement, technology, and subsistence behavior in archaeologically detectable ways. Given the lack of chronological resolution, we start with the working assumption that temporal change in these factors has

TABLE 1. RADIOCARBON DATES FROM TEST EXCAVATIONS IN ARCHAEOLOGICAL SITES OF SOUTHERN SAKHALIN ISLAND DURING SUMMER 2000 RESEARCH

SITE	RECOVERY CONTEXT	FS #	LAB #	$^{14}\text{C}$ AGE	MATERIAL*	CALIBRATED RANGE AT 2 SIGMA (INT)†
Sosuya	TP3 (60–62 cmbs) sediment sample from charcoal layer—dates terrace stabilization	SK71	AA-42202	$2174 \pm 43$	CH	B.C. 378 (201) 92
Sosuya	TP4, base of midden (75 cm), date rejected	SK69	AA-40953	$111 \pm 39$	CH	A.D. 1671 (1699, 1723, 1814, 1832, 1879, 1915, 1949) 1954
Solov'yevko 1	Trench 1, Unit 2	SK27	AA-40952	$1477 \pm 36$	CH	A.D. 534 (601) 653
Solov'yevko 2	Trench 1, Unit 4, near hone	SK7	AA-40951	$668 \pm 42$	CH	A.D. 1276 (1298) 1398
Lyutoga 1	Base of shell midden in erosion face	SK76	AA-40954	$1896 \pm 42$	CH	A.D. 24 (88, 100, 125) 236

\* CH = wood charcoal; † Stuiver et al. 1998.

not overwhelmed spatially meaningful patterning in these temporally aggregated assemblages. As archaeologists interested in issues of evolutionary process, we recognize potential problems with this assumption. Initial colonists should be less familiar with local resources than veteran populations. Larger and more sedentary groups may rely more heavily on established trade networks and less on mobility than smaller groups. And human hunting, gathering, and settlement, especially in small and remote islands, should more easily affect indigenous resources and limit human sustainability. Indeed, our long-term goals in this project are specifically to look at the historical ecology of human-environmental interactions and temporal change with respect to relative isolation. Nevertheless, geography would have imposed similar constraints on all hunter-gatherer populations known to inhabit the region throughout the past. For example, mobility or trade could provide access to quality raw materials, but would both have been equally constrained by the difficulties and hazards of travel between more remote islands? As in the Aleutian Islands, we can expect geography to condition patterns of cultural interaction (Corbett et al. 1997; Veltre 1998). Likewise, while insularity should render more remote islands more vulnerable to human impacts, these should only exaggerate predictions of biogeographical variability. Time-averaged assemblages should still reveal spatially meaningful variability.

### *Chipped Stone Analysis*

Geographically imposed constraints on mobility, trade, and raw material sources in an island chain like the Kurils are expected to lead to predictable patterning in raw material variability and lithic reduction strategies. Here we examine the spatial patterning observed in raw material and flake morphology of debitage.

Lithics, like other artifact classes, were collected from three contexts: test excavations, erosion profiles, and surface distributions. Test excavations included relatively small shovel test pits and trenches of non-standard size (ranging from 1 to 36 m<sup>2</sup>). Excavations proceeded by "natural" stratigraphic zones. Erosion profiles were cleaned, illustrated, and sampled, with artifacts found in situ collected by stratigraphic zone. Surface collections from dune blow-outs, stream channels, and the base of eroding profiles yielded the largest proportion of lithic materials.

Two constraints affect the current analysis. First, as already noted, these data are not suitable for consideration of temporal variability in tool production because of the collection contexts (primarily surface collections). Second, analysis of technological sequences is limited by the necessary separation of the formal tools (left in Russia for curation at the Sakhalin Regional Museum) and the debitage (sent to the University of Washington for processing and analysis). Here we focus on the strengths of the debitage sample, which is appropriate for a preliminary examination of stone tool production variability as it was affected by raw material access and geographical isolation.

The analyses focus on the debitage assemblage, totaling over 1300 individual pieces (see Table 2), and are directed at addressing two major questions: (1) Does relative isolation of human occupation affect raw material consumption and curation patterning? (2) Does the distribution of debitage support a model of archipelago-wide cultural integration, migration, and trade?

Debitage analysis is often conducted at different scales, ranging from the in-

TABLE 2. RAW COUNTS OF DEBITAGE FROM NORTHERN, CENTRAL, AND SOUTHERN KURIL ISLANDS AND SOUTHERN SAKHALIN ISLAND DIVIDED BY RAW MATERIAL CLASS

	NORTHERN ISLANDS	CENTRAL ISLANDS	SOUTHERN ISLANDS	SAKHALIN	TOTAL
Black chert	19	62	—	—	81
Chalcedony	15	77	32	—	124
Green chert	—	42	13	—	55
Obsidian	12	20	—	4	14
Phaneritic igneous	48	169	5	28	260
Red chert	24	168	—	19	211
White chert	—	11	7	96	114
Other	28	215	37	164	456
Total	146	764	94	311	1315

dividual artifact to entire populations (Andrefsky 1998, 2001; Morrow 1997). Analysis at a population level attempts to examine a range of debitage variability in order to make inferences about human behavior. While typological approaches are useful for dealing with a number of interesting issues (Ahler 1989; see also Sullivan and Rosen 1985), the small sample size per site, wide distribution of sites, less than complete recovery of debitage, and the separate repository of formal tools from debitage all limit the usefulness of such an approach. While we recognize some of the methodological drawbacks, an attribute approach is suitable for an initial investigation of our research questions.

A preliminary concern for the debitage analysis was the compatibility of collections assembled via different sampling strategies. A nonparametric multiple comparison test was used to compare artifact characteristics across the four different sampling strategies (shovel test pits, test trenches, stratigraphic profiles, and surface scatters). Using a Kruskal-Wallis test of multiple variance, we determined that in all cases, the hypothesis that all distributions are comparable across sampling methods was supported at the  $p = 0.10$  significance level. Given these results we believe that statistical validity and robusticity can be maintained with the inclusion of all lithic debitage sampled during the 2000 field season. Lithic assemblages have been aggregated into three Kuril groups and Sakhalin as a fourth group. The northern Kurils extend from Shumshu to Shiashkotan, the central Kurils run from Matua to Simushir, and the southern Kurils extend from Chirpoi south. In this analysis, the southern islands are represented only by sites on Chirpoi and Urup Islands and are therefore considered more isolated than the northern islands. Lithic samples from the Kurils are dominated by three assemblages, one from each island group. These are Baikova 1 in the northern Kurils, Brou-tona Bay (1 and 2) in the central Kurils, and Peschanaya Bay 1 in the southern islands (see Fitzhugh et al. 2002 for site details).

The first goal of the debitage analysis is to examine the degree of raw material procurement and distribution variability across the islands. An economic atlas for the Kurils and Sakhalin shows variation in bedrock classes (FINECO 1994; see discussion below), but specific raw material sources are unknown. Obsidian sources from Hokkaido are documented (e.g., Kuzmin et al. 2002) and obsidian

sources from the Kamchatka Peninsula are known to exist but are not yet characterized sufficiently for sourcing (Yaroslav Kuzmin, pers. comm. 2003).

Given the lack of published information on other potential source materials for the Kuril archipelago, we approach the problem inductively, seeking to infer source regions from the distributional properties of archaeological assemblages themselves. We expect the distribution of raw material classes throughout the chain to be a function of the location of sources and the degree of cultural interaction (trade or migration) throughout the islands. More widespread and even distributions are expected to co-occur with people moving frequently through the islands or trading on a regular basis. Conversely, relative isolation should lead to smaller and less even distributions of raw materials. Significant barriers to migration or trade should show up as distinct boundaries in raw material distributions. If all significant lithic sources were located outside of the Kurils, as Russian archaeologists currently believe (Valerii Shubin, pers. comm. 2000), we would expect distributions to be continuous to the extent of population movement/exchange into or through the island chain. If islanders were connected primarily to one end or the other of the chain, raw material use should derive predominantly from one source direction to the near exclusion of the other. Conversely, population interaction through the entire chain would result in the spread of raw materials from both ends, more or less throughout the chain. In this case, we expect proportional representation of raw materials to reflect the source of greatest accessibility, which, all else being equal, would be the closer one. If important raw material sources were available *within* the Kurils, we would expect to see raw material types represented with distributions centered in the vicinity of the source island (as opposed to the ends of the chain). All of these predictions assume that raw materials have single source locations. Materials with multiple, geographically distinct source locations (within or from both sides of the archipelago) should be represented by multimodal distributions. Sample limitations prevent definitive resolution of these alternatives, but our analyses allow tentative conclusions that are both interesting and provide hypotheses for future research on larger samples.

In order to assess the geographic distribution of recovered lithic material types, we first examine the degree to which the island groups represent statistically discrete populations of raw material types. A discriminant analysis was used to determine whether or not island groups could be separated on the basis of one or more factors (following methods outlined in Huberty 1994). The four island groups are significantly different in lithic material representation on the basis of two factors. From this, we reject the hypothesis of uniform raw material class distribution throughout the archipelago. If supported, this hypothesis had been expected to indicate occupation by rapidly moving and/or well-integrated populations throughout the Kurils (see also below). Instead, these results suggest that the flow of raw materials through the island groups was restrained. Two problems exist with this analysis, however. First, both functions have extremely small eigenvalues (function 1 = 0.114; function 2 = 0.026). Additionally, group centroids, while discriminated, seem to be distributed fairly close to one another. This may contribute to the low eigenvalues and suggests that there was some degree of interaction in raw material movement between island groups, which should not be surprising.

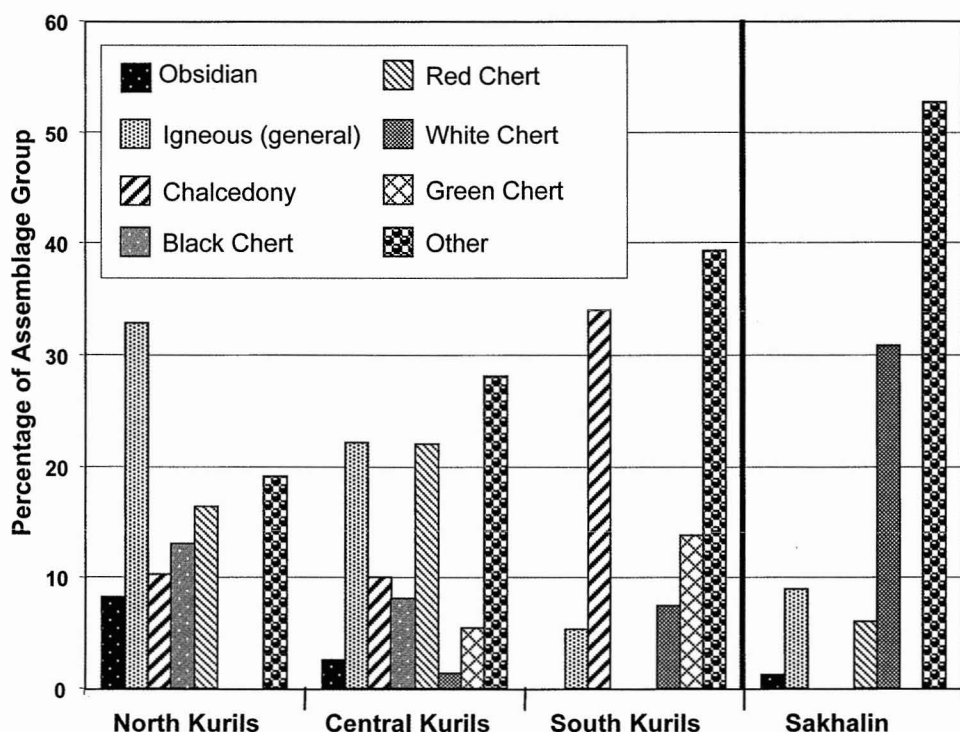


Fig. 2. Distribution of common debitage raw materials isolated by island group. Only material that accounted for 5 percent of the material in at least one island group was reported as an individual category. All other material was included in the "Other" category.

The proportional distribution of raw material classes throughout the chain provides a clearer look at the variation across the island groups. In Figure 2, dominant classes are plotted by island group. This distribution raises several points concerning raw material distributions:

1. Small amounts of obsidian are found in the northern and central islands and on Sakhalin. While no Kuril obsidian sources are known, it is interesting that the obsidian from the central islands is different in texture and translucence from that found in the north islands. This may indicate different geographical sources, and associated differences in orientation of mobility and exchange patterns. Ongoing research seeks to compare these obsidian varieties to sources in Kamchatka and Hokkaido outcrops. Absence of obsidian in the southern island samples suggests against a southern origin.

2. Igneous raw materials (primarily fine-grained varieties), black chert, and red chert dominate in the north and central Kurils (Shumshu to Simushir). The igneous materials could have come from local sources (localized dacite, andesite, and basalt bedrocks are reported on Shumshu, Paramushir, Onkotan, Simushir, Urup, Iturup, and Kunashir; FINECO 1994).

3. The predominance of red chert in the central Kurils could indicate a local source for this variety. While we believe there may be room for revision of the



established geological maps, available geological information fails to indicate any nonvolcanogenic sedimentary complexes anywhere in the Kurils. Taking this into account, our distribution points toward a northern source on Kamchatka.

4. Chalcedony and green chert dominate in the south Kurils (Chirpoi and Urup) and are presumed to derive from Hokkaido, but could also come from the southern islands. As mentioned above, the geological data do not currently support a Kuril origin for any sedimentary lithologies.

5. White chert increases in relative importance from the central to southern Kurils and may be a Hokkaido import. White chert with hematite is found predominantly in Sakhalin. We suspect that there is more than one source area for the white cherts between Hokkaido and Sakhalin, with the hematitic variety most likely local to southern Sakhalin.

Numerous other classes are represented in such low frequencies that their inter-island group patterns are of uncertain significance. The "other" category in Figure 2 is a good proxy for material diversity, and the patterns show that the diversity of minor raw materials increases from north to south and then to Sakhalin. This may represent greater variation in available lithic sources in Hokkaido and Sakhalin (compared to Kamchatka) and/or more common population movement into the Kurils from the south. The culture history and radiocarbon evidence (Befu and Chard 1964; Chubarova 1960; Fitzhugh et al. 2002; Stashenko and Gladyshev 1977) supports the latter hypothesis.

Summarizing the evidence presented in Figure 2 for the Kuril Islands, in almost all cases raw material distributions appear to be unimodal and centered at one or the other end of the Kuril chain. This is the pattern expected for single off-island sources and distribution patterns anchored to one or the other end of the archipelago. The north-dominated and south-dominated suite of materials overlaps in the central Kurils, but most classes (other than potentially local igneous-volcanic varieties) are not found from one end to the other. This implies that prehistoric mobility/exchange was constrained by geographical isolation. If populations moved through the chain, as we expect they did by the Okhotsk and Ainu periods, this movement was not rapid enough or easy enough to support dependence on a single suite of choice material types (at least of materials represented in our samples). If the Kurils were colonized from both ends of the chain, this bipolar pattern would suggest continued use of traditional off-archipelago sources. If the islands were colonized predominantly from the south (as appears likely), the northern pattern implies settlement of sufficient duration to develop access to Kamchatka sources. Stepan Krasheninnikov (1972:58–59) notes that the Kuril Ainu on Shumshu Island had intermarried with Kamchadals of the southern Kamchatka Peninsula. North Kuril Ainu were known to have engaged in trade of various products, such as eagle feathers, with their Kamchadal neighbors (W. Fitzhugh 1999:10). Given the prehistoric patterning presented here, it seems likely that similar interaction patterns existed between the Kuril Islands and Kamchatka into the past.

Together these observations indicate that during the course of the past 2500 years, the Kurils were: (1) sufficiently isolated to constrain the spread of nonlocal raw materials and (2) settled permanently enough to support the development of selective systems of economic raw material utilization. Finally, the apparent off-

archipelago (or end of archipelago) source locations lead us to expect curation behavior to intensify with insularity. This brings us to the second set of questions and analyses to be considered here.

To the extent that lithic production and performance is affected by raw material variability, raw material utilization and curation practices should be greatly affected by insularization and source distance. We predict that if insularity affected resource availability and thereby increased the need for curation, then several morphological patterns should be manifest in the data: (1) the mean percentage of dorsal cortex found on flakes from more insular environments should be lower than the percentage of cortex found on flakes from less insular environments; thus, Kuril Islands lithic flakes should have lower mean cortex percentages than flakes from Sakhalin; (2) dorsal flake scar density on Kuril Island assemblages should be higher than Sakhalin assemblages since tool manufacturers would have been compelled to extract more usable flakes from the less abundant core material; (3) striking platforms among Kuril Island lithics on the whole should be more faceted since cores would need to be more extensively worked; thus flakes from Sakhalin should have a higher proportion of lisse platforms; and (4) mean flake size should be smaller among Kuril Island lithics than among Sakhalin lithics due to both the transport costs entailed in moving large pieces of flaking material and the need to exhaust cores for usable flakes.

Several measures support increased lithic curation among the most insularized islands in the Kuril chain (Table 3). First, as expected, the average percentages of dorsal surface cortex on lithics from the Kuril Islands are low (ranging from less than 20 percent on the central island assemblages to 45 percent on the south islands) while the average percentage on the less insular Sakhalin Island is dramatically higher at 65 percent (Fig. 3a). This suggests that cores in the Kuril Islands tended to produce more flakes than those on Sakhalin.

Second, the average size of lithics from the Kuril Islands is much smaller than that of lithics from Sakhalin (Fig. 3b). This suggests that lithic material from the more insular sites tended to be more heavily exploited. Interestingly, the smallest mean artifact sizes came from the southernmost islands of the Kuril chain. However, this pattern is expected if one considers that this island group is represented by the most insular and the most northern sites within this island group (Chirpoi and Urup). Also of note here is that the relative ranking between island groups changes somewhat between these two measures: the central Kuril lithics have the smallest mean cortex percentages while the southern islands have the smallest mean size class. This reversal of the "curation" pattern can probably be accounted for by the fact that the southern islands are dominated by chalcedony, a material that is not well represented in any of the other island groups and that tends to occur in small nodules (Fig. 2).

Third, the results of the striking platform analysis support the hypothesis that a higher proportion of faceted platforms would be found on flakes from more insular island groups. Faceted platforms tend to be quite common in the central and southern groups but noticeably less so among Sakhalin assemblages. Again, this suggests that stone core material was more heavily exploited in the Kuril Islands.

Finally, the results of flake scar density analysis seem more equivocal. When considering the Kuril Island data, the dorsal flake density is highest on the central

TABLE 3A. RAW COUNTS OF DEBITAGE FROM NORTHERN, CENTRAL, AND SOUTHERN KURIL ISLANDS AND SOUTHERN SAKHALIN ISLAND DIVIDED BY PERCENTAGE OF DORSAL CORTEX

	NORTHERN ISLANDS	CENTRAL ISLANDS	SOUTHERN ISLANDS	SAKHALIN	TOTAL
0% cortex	95	581	52	153	881
1–25%	23	72	26	55	176
26–50%	9	25	8	42	84
>50%	8	5	3	20	36
Total	135	683	89	270	1177

TABLE 3B. RAW COUNTS OF DEBITAGE FROM NORTHERN, CENTRAL, AND SOUTHERN KURIL ISLANDS AND SOUTHERN SAKHALIN ISLAND DIVIDED BY ARTIFACT SIZE

SIZE (MM)	NORTHERN ISLANDS	CENTRAL ISLANDS	SOUTHERN ISLANDS	SAKHALIN	TOTAL
1–3	12	281	4	7	51
4–6	43	213	37	48	341
7–9	47	306	35	103	491
10–12	13	74	7	57	151
13–15	8	32	4	31	75
16–18	5	5	—	12	22
19–21	3	6	—	3	12
22–24	3	16	2	7	28
25–27	1	1	—	1	3
28–30	—	2	—	—	2
Total	135	683	89	269	1176

Note: Size classes are grouped here for brevity.

TABLE 3C. RAW COUNTS OF DEBITAGE FROM NORTHERN, CENTRAL, AND SOUTHERN KURIL ISLANDS AND SOUTHERN SAKHALIN ISLAND DIVIDED BY NUMBER OF DORSAL FLAKE SCARS

NUMBER OF FLAKE SCARS	NORTHERN ISLANDS	CENTRAL ISLANDS	SOUTHERN ISLANDS	SAKHALIN	TOTAL
0	20	138	24	283	210
1	15	77	10	19	121
2	22	76	14	41	153
3	20	116	9	36	181
4	10	60	6	24	100
5+	48	216	26	121	411
Total	135	683	89	269	1176

Note: Only flakes are included in this analysis.

islands as expected (Fig. 3c). However, Sakhalin boasts the highest average number of flake scars among its lithic assemblages. At first glance, this suggests that raw materials were most heavily utilized in Sakhalin, which seems unlikely given its greater geological complexity and access to alternate avenues for material pro-

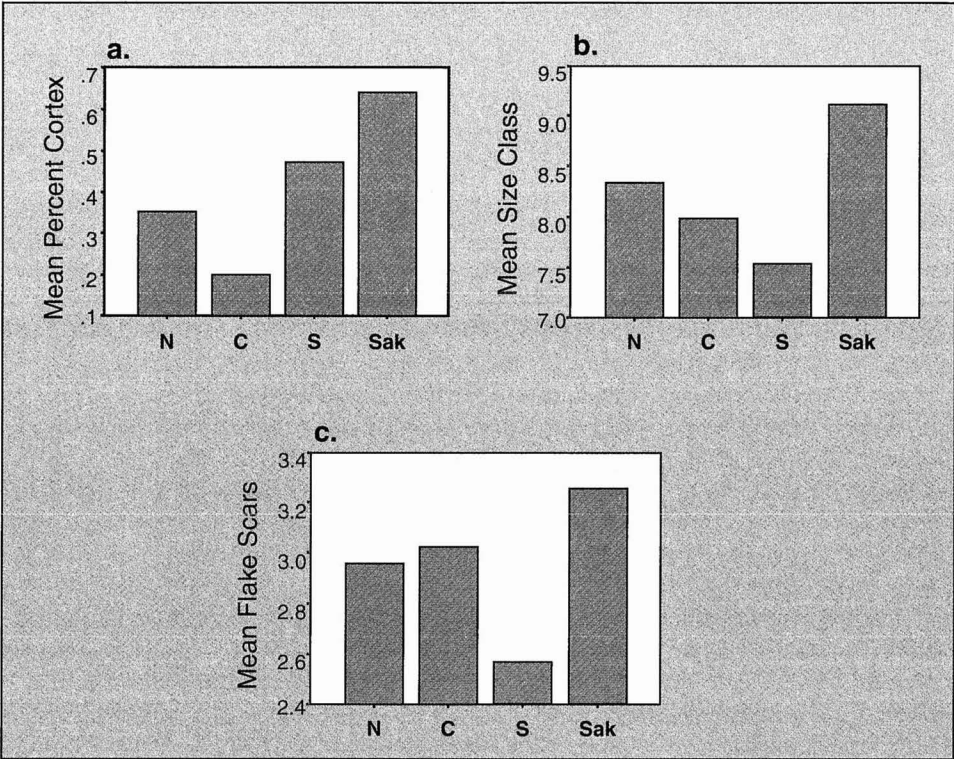


Fig. 3. Measures of intensity of stone tool conservation (curation) recorded for debitage by island group (see Table 3): a: Mean percentage of dorsal cortex identified on material separated by island group. Higher average percentages indicate increased amounts of primary flakes and therefore diminished resource exploitation. As expected, the central islands, which are the most insular, demonstrate the lowest mean percentage of dorsal cortex; b: mean size class of artifacts separated by island group. Size class values represent the longest axis on a particular artifact and are arbitrary designations used for statistical computation. Size class 7 is equivalent to 2.0 inches; size class 8 is equivalent to 2.5 inches, etc. This method is described in Andrefsky (1998); c: mean number of flake scars for assemblages from the four major island groups. Higher values suggest more intensive use of raw material. Notice the disparity between the southern islands and the other groups.

curement. The lack of strict correlation between the other measures, which conform to the hypotheses, and the flake scar density analysis remains a difficulty for this work. However, it seems likely to us that the results of this latter analysis were in fact biased by a noncurational factor. Specifically, we believe that the high correlation between mean class size among artifacts (Fig. 3b) and mean flake scar density (Fig. 3c) is causal in nature: that is, the smaller flakes tend to have fewer identifiable flake scars. Thus, the larger flakes have more identifiable flake scars, making Sakhalin's assemblages produce the highest mean density.

Despite the contradiction in our last hypothesis, we feel that our analysis has successfully shown that Kuril Island lithics tended to be more intensively worked and curated compared to lithics from Sakhalin. This is significant especially when considering the fact that technological processes can often obscure curational practices and their material consequences (Binford 2001). In future research, we

hope to be able to run these analyses on debitage from each raw material class separately (and from different time periods). In this way, it may be possible to examine the role of technological variability in these measures, at least to the extent that technological differences correlate with raw material characteristics (grain size, homogeneity, etc.).

Despite inherent limitations, these debitage analyses provide some insight into human occupations of the Kuril Islands over the past 2500 years. Constraints of travel and trade made it necessary for islanders to draw raw materials primarily from continuous source distributions of greatest proximity (north or south). In the centermost Kurils, conservative measures were often employed in order to extend the useful life of nonlocal materials, suggesting that access to this material was limited. The implications of limited lithic raw material sources on other aspects of central Kuril adaptation are currently unknown. Further research, incorporating formal and informal tools as well as debitage, is necessary to test and expand the conclusions presented here.

### *Faunal Analysis*

With the conclusion supported by our lithic analysis that insularity imposes noticeable constraints and demands on islanders, at least in their access to raw materials and on the care they took to conserve it, we turn now to consider the implications of island life on subsistence. A central goal of our archaeological research is the reconstruction of prehistoric biogeographic and human-environmental interaction patterns. Zooarchaeological analysis, involving collection, classification, and quantification of faunal remains represents a key strategy in attaining this goal. As an initial step in the larger paleobiogeographical study, here we focus on a spatial analysis of taxonomic variability of faunal remains from middens at three locations: Baikova 1 on Shumshu Island, Peschanaya 1 on Chirpoi Island, and pooled data from three sites from southern Sakhalin's Aniva Bay region (Sosuya, Solov'yevko 1, Lyutoga). Typological and radiocarbon evidence suggests that the Shumshu and Sakhalin samples come from Okhotsk period sites of about 1000 B.P., while part of the Chirpoi material (fish bones from a pocket midden in the Camp Profile) derive from the Okhotsk or prehistoric Ainu period and part (mammal and bird bones) dates to the historic Ainu period House 31, around A.D. 1750 (Fitzhugh et al. 2002).

Before addressing the geographical variability represented in these assemblages, it is important to consider the comparability of site types and depositional environments. All samples used in this analysis come from midden deposits fronting large pithouse villages. While we do not know the extent of seasonal occupation at any of these sites, the infrastructural investment at each was substantial, and the archaeological records suggest persistent occupation over many years if not decades or centuries. We do have anecdotal evidence from an early ethnohistoric report that Chirpoi Island was only occupied seasonally, supposedly for the exploitation of birds and roots (Krasheninnikov 1972:62). The lack of predictable water supply in this remote location should have limited occupation to seasons when snow or snow melt streams could be counted on for water. Yet the archaeological evidence, with over 40 substantial pithouse depressions (Fitzhugh et al. 2002:77–80) suggests that the occupation that did occur was substantial and en-

during. All of the sites are located on or within 1 km from the marine coast, and all are within several meters of navigable water. We conclude from these observations that the faunal samples collected generally are from similar site types—pithouse villages. With the exception of the sample from Chirpoi (Peschanaya 1), the deposits are roughly comparable in age, falling into the Okhotsk period with dates around 1000 B.P.

The primary purpose of faunal sampling during the 2000 field season was to ascertain the range of taxa likely to be encountered by a sustained archaeological program, to gauge conditions of preservation, and to identify significant logistical issues facing any effort to obtain representative samples from the Kurils. Accordingly, all faunal remains were collected in one of two ways, as part of larger bulk samples, or as nonrandom discretionary samples. Samples are not necessarily representative of the larger population of faunal remains within any particular site in terms of its actual taxonomic, elemental, age class, or sex distribution. Moreover, total assemblage sizes are small (mammals,  $n = 730$ ; birds,  $n = 551$ ; fish,  $n = 972$ ). As a result, the application of robust statistical methods runs the risk of overdetermining the data and identifying patterns that may not be representative. Therefore, rather than pursuing a rigorous quantitative approach in this analysis, we instead take a more descriptive one, utilizing techniques of exploratory data analysis (Hoaglin et al. 1983) to identify suggestive patterns in the data and inductively generate testable hypotheses for future research.

Taxonomic and elemental identifications were made using modern comparative material on loan from the Burke Museum of Natural History Culture, in Seattle, Washington, and from private faunal collections provided by members of the Department of Anthropology, University of Washington. Comparative specimens were unavailable for the entire range of species observed within the region (e.g., Amaoka et al. 2000; Kostenko 2000, 2002; Pietsch et al. 2001, 2003). Additionally, the comparative material lacks variability in terms of age, sex, and pathology. As a result, our taxonomic analysis focuses on family and genus level identifications and the quantification of elements is based on NISP (number of identified specimens) rather than MNI (minimum number of individuals).

Zooarchaeological research has been reported from a variety of regions around the Sea of Okhotsk (e.g., Kodama 1948; Natori 1948; Nazarkin and Lebedintsev 1993; Nishimoto 1978, 1984; A. Okada 1998; H. Okada 1998; Otaishi 1994; Saitô 1938). In this regard, as in others, Hokkaido and Sakhalin are better investigated than Kamchatka and the Kuril Archipelago. Baba (1934, 1937; Baba and Oka 1938) provides one of the few discussions of faunal remains from the Kurils contained in cursory descriptions and partial inventories. Dikova (1983:218–219) provides a brief tabulation of vertebrate fauna recovered from excavations on the southern tip of Kamchatka. Faunal remains are slightly better documented on Sakhalin at Taraika (Baba 1940). One of the more informative zooarchaeological analyses comes from the substantial Moyoro midden in northern Hokkaido (Kodama 1948; Natori 1948).

Based primarily on the Taraika and Moyoro sites, Befu and Chard (1964) provide a generalized synchronic picture of Okhotsk culture subsistence. They suggest that the Okhotsk culture represented the “first appearance of the maritime way of life in the Okhotsk Sea area” (Befu and Chard 1964:1) with a diet focused heavily on sea mammals, supplemented seasonally by fish, shellfish, birds, and



occasionally terrestrial mammals. Unfortunately, the issue of spatial variability is addressed only briefly, and, probably because Befu and Chard were concerned only with the Okhotsk culture, there is no consideration of subsistence changes through time. More recent research documents sea-mammal hunting at many locations along the coast of Hokkaido, including the northern shore adjacent to the Sea of Okhotsk, during the late Middle Jomon and early Late Jomon period (e.g., Niimi 1994; Nishimoto 1984). To our knowledge, none of this work has considered the role of biogeographical variation on subsistence practices across these regions.

The bulk of the IKIP 2000 faunal assemblage derives from a time in which the Okhotsk culture extended from Sakhalin around the southern Sea of Okhotsk and up to the northern Kurils. As a result, we can venture some comparisons to Befu and Chard's generalized model. Moreover, because our largest samples come from three widely spread locations, each with different biogeographical characteristics (Shumshu in the northern Kurils, Chirpoi in the south central Kurils, and several midden sites on southern Sakhalin), we can examine subsistence variability across space, particularly within the Okhotsk cultural horizon on Shumshu and Sakhalin. As noted above, the Chirpoi sample likely includes remains from Okhotsk as well as Ainu occupations, and we stick to the working assumption that meaningful geographical differences can be isolated in this cross-temporal analysis. As it turns out, this assumption appears sustainable.

Given anticipated differences in biogeography from continents to isolated islands, prehistoric terrestrial fauna should have been most diverse on Sakhalin, followed by Shumshu, and then Chirpoi. By contrast, highly mobile marine and bird fauna should predominate in the most isolated island regions. Thus, if prehistoric hunter-gatherers were sampling the endemic taxa in rough proportion to their natural availability, the Sakhalin sites should have the highest terrestrial diversity ("taxonomic richness"), while the Kuril sites, especially Chirpoi, should be most diverse in marine and bird taxa. As Table 4 and Figure 4 illustrate, this biogeographic expectation is met in comparing Sakhalin and the Kurils, but the observed pattern within the Kurils is the reverse from that expected between Shumshu and Chirpoi. Sakhalin samples represent more taxonomic richness than Chirpoi, but Shumshu has the greatest richness of all. There are good explanations for this pattern.

It is widely recognized that human hunter-gatherers, and predators in general, do not sample the environment in proportion to naturally occurring biotic diversity and productivity (e.g., Broughton 1994; Grayson 1984). Foragers are selective, and bias is often shown for the most profitable taxa (i.e., those having the greatest post-encounter return rate). Optimal Foraging Theory provides a series of approaches to modeling human foraging selectivity (Kaplan and Hill 1992; Stephens and Krebs 1986). For our purposes, the diet breadth model (also called the prey choice model) suggests a reasonable explanation for the biogeographically anomalous pattern observed in the Kuril fauna. This model suggests that foragers will tend to focus on a small number of high return prey when those animals are plentiful and increase the variety (taxonomic richness) of prey pursued when the high return resources decline in availability (Kaplan and Hill 1992). Archaeologists often use prey size for an approximation of the relative importance of taxa in the diet of prehistoric hunter-gatherers.



TABLE 4. TABULATION OF ARCHAEOFAUNA TAXA (NISP) BY ARCHAEOLOGICAL SITE FROM IKIP 2000 SURVEY IN THE KURIL AND SAKHALIN ISLANDS

	SHUMSHU	CHIRPOI	SAKHALIN		
	BAIKOVA	PESCHANAYA	LYUTOGA	SOLOV'YEVKA	SOSUYA
Mammals (genus)					
<i>Aloplex</i>	—	—	—	—	3
<i>Callorhinus</i>	2	—	—	—	—
<i>Canis</i>	—	—	2	—	—
<i>Cervus</i>	—	—	—	1	—
<i>Enhydra</i>	—	1	—	—	—
<i>Eumetopias</i>	4	10	—	—	—
<i>Lepus</i>	—	—	—	—	1
<i>Martes</i>	—	—	—	—	2
<i>Phoca</i>	6	2	17	15	5
<i>Rattus</i>	—	—	1	21	—
<i>Sus</i>	—	—	—	—	1
<i>Vulpes</i>	—	—	—	—	1
<i>Zalophus</i>	2	—	—	—	1
Indeterminate	64	227	52	216	70
Birds (genus)					
<i>Aethia</i>	16	—	—	—	—
<i>Anthya/Mergus</i>	—	—	—	1	—
<i>Branta/Cygnus</i>	1	—	—	—	—
<i>Catharacta</i>	1	—	—	—	—
<i>Clangula</i>	5	—	—	—	1
<i>Diomedea</i>	1	—	—	—	—
<i>Fratercula</i>	1	1	—	—	—
<i>Gavia</i>	2	—	—	—	1
<i>Haliaeetus</i>	1	—	—	—	—
<i>Histrionicus</i>	3	—	—	—	—
<i>Hymalis</i>	—	—	—	—	1
<i>Larus</i>	10	—	—	—	—
<i>Lunda</i>	2	1	—	—	—
<i>Melanitta</i>	1	—	—	—	—
<i>Pandion</i>	1	—	—	—	—
<i>Pelagicus</i>	4	—	—	—	—
<i>Phalacrocorax</i>	20	5	—	—	—
<i>Puffinus</i>	—	35	—	—	—
<i>Uria</i>	1	2	—	—	1
Indeterminate	82	325	7	4	14
Fish (family)					
Cottidae	6	—	—	—	—
Clupeidae	—	2	—	—	62
Gadidae	195	—	2	—	7
Hexagrammidae	—	223	—	—	—
Lamnidae	—	—	—	—	2
Pleuronectidae	46	—	3	2	18
Salmonidae	24	—	—	—	6
Shark*	—	—	—	—	2
Indeterminate	80	123	7	—	162
Total Mammals	78	240	73	253	86
Total Birds	152	369	7	5	18
Total Fish	351	348	12	2	259
Total Specimens	581	957	92	260	363

\*sharks are identified to class rather than family level.

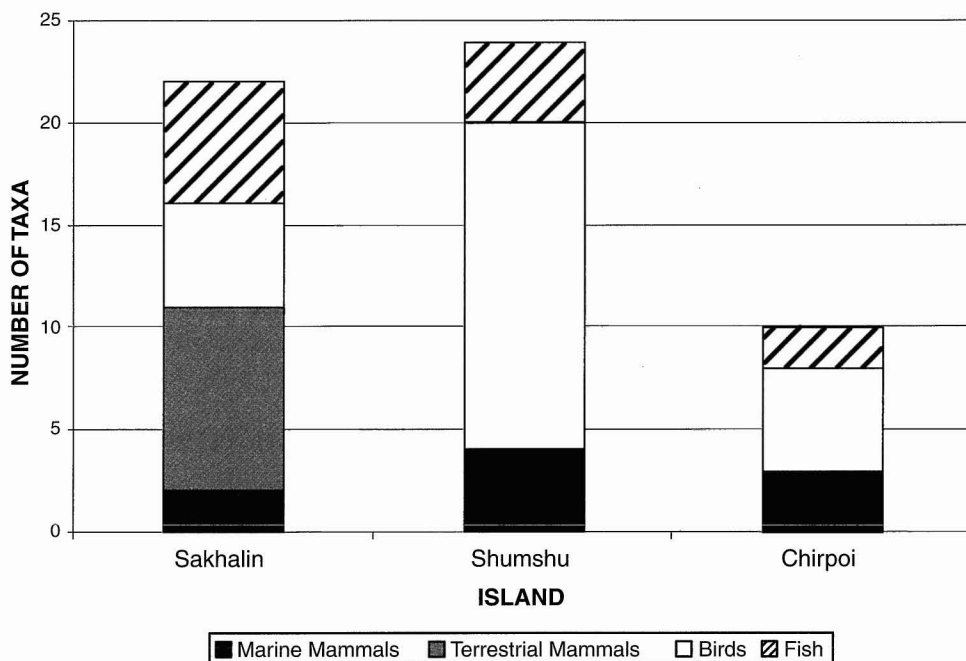


Fig. 4. Taxonomic richness by location. Bars distinguish major classes (birds, terrestrial mammals, marine mammals, and fish). Bar height reflects number of taxa by genera within major classes. Mammals and birds are identified to genus; fish are identified to family.

Returning to the data, we can readily see that hunter-gatherers would have different optimal diets in landscapes with high biotic diversity and a great deal of dietary choice. In diverse (typically more continental) environments choice would have been high and foragers could afford to focus on the large and highly productive resources and ignore many of the smaller and less profitable taxa. By contrast, environments of low resource diversity place limits on foraging choice. From this observation, we can predict that Sakhalin foragers should have experienced the greatest variety of options of any of the locations sampled here. But they should have been most selective, leading us to expect only the largest bodied and/or most easily processed of taxa in these fauna.

As shown in Figure 4 and Table 4, Sakhalin samples are dominated by marine and terrestrial mammals, mostly medium- to large-bodied varieties such as sea lion (*Zalophus*), seal (*Phoca*), deer (*Cervus*), dog (*Canis*), fox (*Alopex* and *Vulpes*), and pig (*Sus*). Foraging theory predicts seasonal expansion of diet breadth during periods of lower than average foraging success (Kaplan and Hill 1992), which may account for the presence of some smaller and less desirable taxa such as fox, marten, hare, and rat. Some of these were probably harvested for their fur, as opposed to caloric value, and are expected to defy foraging theory predictions that are generally based on the assumption that caloric return rates are dominant in foraging decisions.

The Sakhalin sample is the only sample with terrestrial mammals, but Shumshu, still relatively near to Kamchatka, has by far the greatest overall diversity,

built on the high richness of bird taxa. This trend is also reflected in a preliminary analysis of shellfish (data not included in this report), where nine taxa have been identified from Shumshu, and only three have been identified in our Sakhalin sample. From this we conclude that populations in the northern Kurils were exploiting a wider variety of relatively low-quality subsistence resources (birds and shellfish) compared to their contemporaries on Sakhalin. That is, the Shumshu faunal assemblage includes fewer high-ranked and more lower ranked resources compared to Sakhalin. Sakhalin has several medium- and large-bodied wild (e.g., deer) and domesticated (e.g., pig and dog) mammals in addition to the marine mammals that both locations share. Thus for the Sakhalin and Shumshu comparison, human selectivity within the context of predictably different biogeographical regimes (more continental and more insular) appears to account for the differences in taxa recovered.

The low taxonomic richness of the Chirpoi sample suggests that taxonomic diversity was biogeographically limited to start with. In such an environment, hunter-gatherers may have had such a low menu of options as to severely constrain diet breadth. Critically, this low richness is not a function of sample size, as Chirpoi has the largest sample (NISP) of the three locations (Fig. 5). This low degree of natural resource diversity may account for ethnohistoric observations that this island was visited only seasonally (Krashennnikov 1972:62), in which case, forays were targeting specific resources that could be found there.

These interpretations are supported further by an analysis of fish remains from the Kuril and Sakhalin assemblages (Boone 2002). In relative abundance, fish

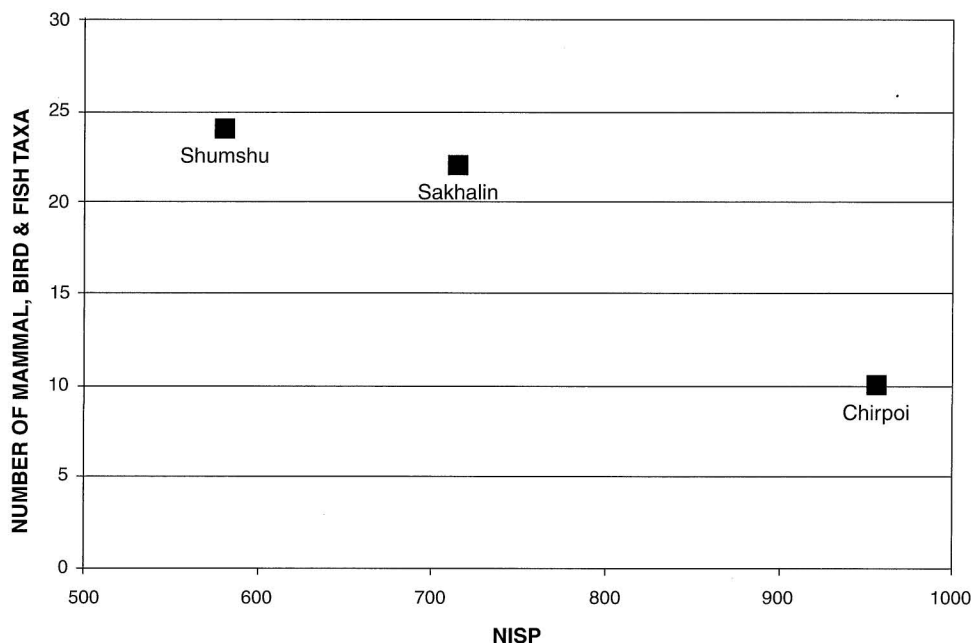


Fig. 5. Taxonomic richness against total NISP by location. This graph illustrates the strong relationship between insularity and taxonomic richness. The relationship is independent of sample size: Chirpoi is the most insular, has the largest total NISP, and the lowest richness.

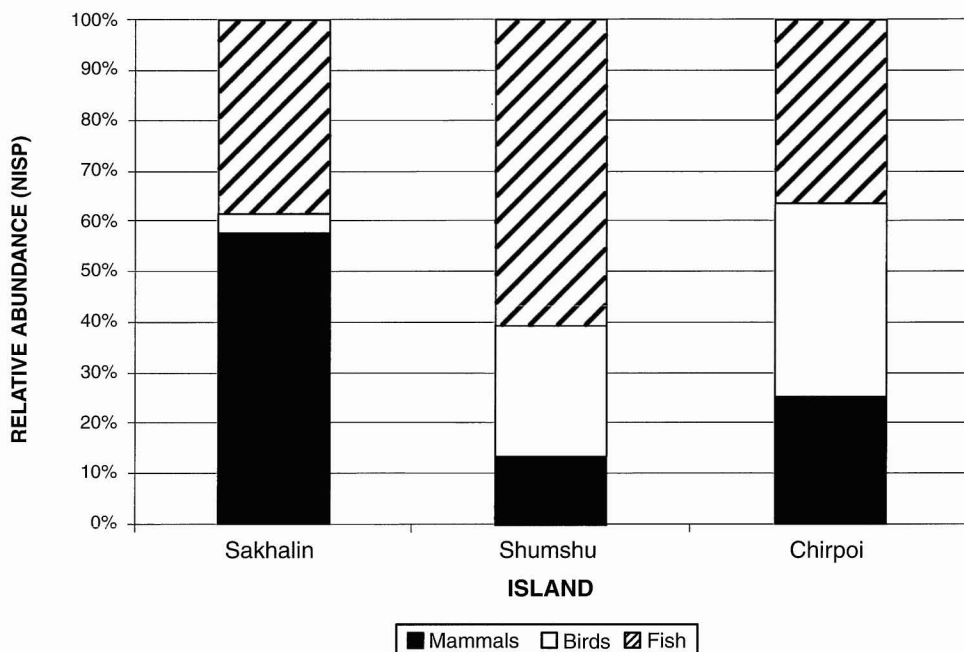


Fig. 6. Taxonomic relative abundance (bird, fish, mammal) by location.

comprise 60 percent of the Shumshu fauna, 36 percent of the Chirpoi sample, and 38 percent of the aggregated Sakhalin sample (Fig. 6). As expected, fish represent a significant component of the Kuril diet, particularly on Shumshu. Because fish could be identified only to family level, while the mammals and birds are identified to genus, combined taxonomic richness is meaningful only between islands, not across single assemblages. A wider range of fish taxa was exploited on Shumshu compared to Chirpoi. This pattern is attributed to greater natural taxonomic diversity arising from Shumshu's possession of perennial streams, supporting anadromous fish such as salmon, and to the island's relative proximity to the Kamchatka Peninsula, where source populations of anadromous and nearshore fish are plentiful. Chirpoi's greater isolation and absence of perennial streams suggest that this island would have supported fewer fish taxa. In support of these differences, we find salmon representing nearly 9 percent of the fish remains identifiable to family from the Shumshu (Baikova 1) sample, while salmon remains are absent from the Chirpoi (Peschanaya 1) sample. In fact, a single family (Hexagrammidae) comprises more than 99 percent of the fish identifiable to family in the Chirpoi sample. This uniformity may again reflect the limited set of resources within the isolated central Kurils. It may also reflect a narrower season of occupation on Chirpoi compared to the other locations, or a bias in sampling a single-event deposition.

Our prey choice model predicted a relatively narrow diet breadth on Sakhalin due to the presence of medium- and large-bodied terrestrial mammals. This expectation is met in the bird sample. The combined Sakhalin sample contains less than one-third of the number of bird genera found in the Shumshu assemblage. Sakhalin and Chirpoi bird diversity is comparable (five genera each), which again

appears to relate to the limited diversity of taxa available on Chirpoi (a biogeographical issue) and the selectivity of hunter-gatherers on Sakhalin (a diet breadth issue). Our diet breadth prediction is not met in the Sakhalin fish sample, which has the highest taxonomic variability of the three islands. This result is not produced by the aggregation of assemblages from multiple sites, since all six families are found at Sosuya. Despite this diversity, the relative abundance of most fish remains is very low, and several of the taxa (i.e., Gadidae, Lamnidae, Salmonidae, and shark) are represented by only a few identified specimens. Reasons for the high fish diversity in southern Sakhalin sites (specifically Sosuya) probably relate to the sites' location on the tidal range of a large fishing stream. Technologies for mass harvesting of fish often elevate the importance of fish beyond expectations based on individual body size (Madsen and Schmidt 1998), especially where population densities are relatively packed, and foraging mobility limited. The presence of several Okhotsk period sites near the head of Aniva Bay suggests this possibility.

While higher relative abundances of fish and birds are found in the Kurils, the faunal assemblage from Sakhalin is dominated by mammals, with significant contributions from both terrestrial (e.g., pig) and marine (e.g., seal) taxa (Fig. 6). Domesticated pig and dog have been reported previously from Okhotsk period sites (Nishimoto 1978, 1984; Otaishi 1994; Saitô 1938) and were likely important components of the diet on Sakhalin during this period. One intriguing pattern evident in the Sakhalin data is a very distinct difference between the faunal assemblages from Solov'yevko 1 and Sosuya. The Sosuya assemblage is diverse, consisting of 17 different taxa, including seven genera of mammals, four genera of birds, and six families of fish. On the other hand, the Solov'yevko 1 assemblage includes just five taxa, with three genera of mammals, one bird genus, and one fish family. The observation that pigs represent the most abundant taxa at Solov'yevko 1, while they are absent from the Sosuya assemblages may suggest a difference in economic focus at these two sites. If people were producing their own food through animal husbandry, we would expect the reduction in diet breadth observed in the Solov'yevko 1 assemblage. The presence of pig remains in this assemblage supports this possibility. On the other hand, Sosuya, while only a few kilometers away, might have focused more on fishing and hunting, as that assemblage suggests. These patterns may reflect seasonal variation or economic specialization in the Aniva Bay Okhotsk period. A prediction can be drawn from this that intersite variation in economic orientations should be greater on more continental islands (like Sakhalin) and least on insular islands (like Chirpoi). Smaller and more isolated islands should have more limited economic opportunities. To address this prediction and to further substantiate the interpretations just given will require further investigation of a larger number of sites with bigger samples.

Despite the provisional nature of these analyses, the patterns observed in these data are consistent with the expectations of human biogeography and foraging theory. They appear to reflect the constraints of relative insularity on human hunting and gathering, and they suggest that larger and better-dated samples from the Kurils will be able to provide sufficient evidence for the dynamic interaction between humans and economically important Kuril biota at least for the past 2500

years. The addition of a diachronic perspective is critical for extending this analysis in the future.

### CONCLUSIONS

The results of this study, while preliminary in many respects, demonstrate the utility of an island biogeographic approach to questions of human colonization, settlement history, technological, and economic adaptation in island regions. This approach is facilitated by a rare configuration of "stepping stone" islands that limits the direction of human migration and interaction to a single corridor.

The lithic and faunal analyses presented here suggest that economic systems throughout the Kuril chain were constrained by cultural and biogeographical insularity throughout their occupation history, compared to the much larger "mainland-like" island of Sakhalin. Furthermore, the extensiveness and intensity of Okhotsk occupation could easily have impacted indigenous terrestrial and marine biota of economic importance, especially those tethered to relatively isolated and small islands in the Kuril chain. While our faunal analysis did not identify any extinct taxa and our samples are insufficient to identify effects of human impacts on the island faunas themselves (e.g., Broughton 1994; Cannon 2000), we can nevertheless predict that local or regional scale resource depression would have limited human access to insular terrestrial and marine resources. This effect would have been most pronounced in the most insular contexts, where stochastic extinction could be more easily provoked (MacArthur and Wilson 1967). We hypothesize that a decline in population density in the Kurils in the Ainu period (Fitzhugh et al. 2002) was at least partly induced by predatory pressure and resource depression.

In the future, we plan to examine the dynamic interaction between human colonization and settlement, catastrophic environmental change, and ecological stability. We expect to compare the relative impacts of humans, volcanic eruptions, and tectonic processes on island environments and the effects of these impacts on human occupation history. It is likely that changes in adaptation (better navigational technologies and watercraft, economic integration with populations beyond the Kurils, etc.) altered human ability to exploit the more remote islands and withstand localized catastrophic events and their ecological consequences to some degree. Archaeologists working in the Aleutians, the Alaska Peninsula, and Kodiak Archipelago have argued that late prehistoric peoples there had established highly effective social mechanisms for dealing with the effects of volcanic eruptions and ash falls, earthquakes, tsunamis, and sudden changes in relative sea levels (Knecht and Davis 2001; Saltonstall and Carver 2002; see Dumond 1979; Workman 1979). However, earlier archaeological sites in these areas as well as in the Kurils show evidence of significant impacts by localized catastrophic events. Some are often capped with thick volcanic deposits (Dumond and Knecht 2001; Fitzhugh et al. 2002:77–78), or were subjected to tidal inundation. Geographic, social, and demographic isolation would amplify the negative impacts of local catastrophes and would require different adaptive mechanisms than the same processes in less insular situations. Given the demonstrated effects of geographic isolation on both technology and subsistence, as shown in this arti-

cle, we can expect that improved knowledge of the prehistory of the Kurils will further our understanding of the more general relationships between technological and social change and adaptation to relatively insular environments.

#### ACKNOWLEDGMENTS

This research was supported by the National Science Foundation under grant nos. 9505031 (Pietsch, P.I.) and 9910410 (Fitzhugh, P.I.). We thank Ted Pietsch for encouraging us to join the IKIP team and supporting our unusual extension of a project designed to investigate Kuril Island biological diversity. Comparative faunal collections and expertise were loaned to the project by Mike Etnier and Bob Kopperl, and by John Rodzilsky of the Burke Museum. Cheryl Iodice and Kyle Tobler contributed to the results here through long hours identifying zooarchaeological samples. Numerous other students helped clean, sort, and classify debitage and faunal samples. William Fitzhugh, Junko Habu, Miriam Stark, and two anonymous reviewers provided helpful feedback on an earlier draft of this article. It goes without stating that we accept sole responsibility for all errors and omissions.

#### NOTE

1. Throughout this work, B.P. is used to refer to radiocarbon years before present, while B.C. and A.D. are used to refer to calendar years.

#### REFERENCES CITED

- ADLER, G. H., AND M. L. WILSON  
1989 Insular distribution of voles and shrews: the rescue effect and implications for species co-occurrence patterns. *Coenoses* 4:69–72.
- AHLER, S. A.  
1989 Mass analysis of flaking debris: Studying the forest rather than the trees, in *Alternative Approaches to Lithic Analysis*: 85–118, ed. D. O. Henry and G. Odell. Washington, D.C.: Archaeological Papers of the American Anthropological Association 1.
- AMAOKA, K., K. NAKAYA, M. YABE, A. SOMA, S. KAWASAKI, K. NISIDA, S. MASAOA, AND T. W. PIETSCH  
2000 Inshore and freshwater fishes of the Kuril Archipelago, in *Species Diversity of Fishes in the Kuril Archipelago*: 15–28, ed. K. Amaoka. Hakodate: Faculty of Fisheries. Hokkaido University.
- AMOROSI, T., P. BUCKLAND, A. DUGMORE, J. H. INGIMUNDARSON, AND T. H. MCGOVERN  
1997 Raiding the landscape: Human impact in the Scandinavian North Atlantic. *Human Ecology* 25(3):491–518.
- ANDREFSKY, W.  
1998 *Lithics: Macroscopic Approaches to Analysis*. Cambridge Manuals in Archaeology. Cambridge: Cambridge University Press.  
2001 *Lithic Debitage: Context, Form, Meaning*. Salt Lake City: University of Utah Press.
- BABA, M. O.  
1934 Report on the archaeological investigation of Shumshu Island in the northern Kuriles. *Jinruigaku Zasshi*, Tokyo 49(2):39–63 (in Japanese).  
1937 Hunting and fishing implements from the Kurile Islands. *Minzokugaku Kenkyu Tokyo* 3(2):295–337 (in Japanese).  
1940 Archaeological outline of Southern Sakhalin. *Jinruigaku Senshigaku Koza* 17. Tokyo (in Japanese).  
1960 Archaeological excavation on Shumshu Island, Northern Kurils, 1934. *Archives of Archaeology* 7:220–226 (in Japanese).



- BABA, M. O., AND M. OKA  
1938 Archaeological investigation of Shumushu, Kurile Islands, and Taraika, Sakhalin. *Minzokugaku Kenkyu* 4(3): 117–180 (in Japanese).
- BEFU, H., AND C. S. CHARD  
1964 A prehistoric maritime culture of the Okhotsk Sea. *American Antiquity* 30(1): 1–18.
- BELLWOOD, P. S.  
1989 Colonization of the Pacific: some current hypotheses, in *Colonization of the Pacific: A Genetic Trail*: 1–59, ed. Adrian V. S. Hill and Susan W. Serjeantson. Oxford: Clarendon Press.
- BINFORD, L. R.  
2001 Where do research problems come from? *American Antiquity* 66(4): 669–678.
- BOONE, C.  
2002 Optimal Foraging in Remote Island Environments: Archaeological Fish Remains from Far East Russia. Honors Thesis, Department of Anthropology, University of Washington, Seattle.
- BROUGHTON, J. M.  
1994 Declines in mammalian foraging efficiency during the late Holocene, San Francisco Bay, California. *Journal of Anthropological Archaeology* 13: 371–401.
- BROWN, J. H., AND A. KODRIC-BROWN  
1977 Turnover rates in insular biogeography: Effect of immigration on extinction. *Ecology* 58: 445–449.
- BURNEY, D. A.  
1997 Tropical islands as paleoecological laboratories: Gauging the consequences of human arrival. *Human Ecology* 25: 437–457.
- CANNON, M. D.  
2000 Large mammal relative abundance in Pithouse and Pueblo period archaeofaunas from southwestern New Mexico: Resource depression among the Mimbres-Mogollon? *Journal of Anthropological Archaeology* 19(3): 317–347.
- CHARD, C. S.  
1960 *Japanese Source Materials on the Archaeology of the Kurile Islands*. Society for American Anthropology and the University of Wisconsin. No. 7. Archives of Anthropology. Madison.
- CHUBAROVA, R. V.  
1960 Neolithic Sites on Iturup Island, Kuril Islands. *Sovetskay Antropologiy* 2: 28–138 (in Russian).
- CORBETT, D. G., C. LEFÈVRE, AND D. SIEGEL-CAUSEY  
1997 Western Aleutians: Cultural isolation and environmental change. *Human Ecology* 25(3): 459–479.
- DIKOVA, T. M.  
1983 *Arkheologiya Iuzhnoj Kamchatki v Svaizi s Problemoj Passeleniia Ajnov* (Archaeology of Southern Kamchatka Regarding the Problem of Ainu Settlement). Moscow: Nauka Press.
- DUMOND, D. E.  
1979 People and pumice on the Alaska Peninsula, in *Volcanic Activity and Human Ecology*: 373–392, ed. P. Sheets and D. K. Grayson. New York: Academic Press.
- DUMOND, D. E., AND R. A. KNECHT  
2001 An early blade site in the eastern Aleutians, in *Archaeology in the Aleut Zone: Some Recent Research*: 9–34, ed. Don E. Dumond. University of Oregon Anthropological Papers, No. 58. Eugene: University of Oregon Press.
- ETNIER, M. A.  
2002 The Effects of Human Hunting on Northern Fur Seal (*Callorhinus ursinus*). Migration and Breeding Distributions in the Late Holocene. Ph.D. diss., University of Washington, Seattle.
- FINECO  
1994 *Atlas of Sakhalin Region: Resources and Economy*. Yuzhno-Sakhalinsk, Russia: Sakhalin Region Publishing House.

- FITZHUGH, B., AND L. H. TERRY  
1997 Introduction: Islands as laboratories—archaeological research in comparative perspective. *Human Ecology* 25:379–383.
- FITZHUGH, B., V. O. SHUBIN, K. TEZUKA, Y. ISHIZUKA, AND C. MANDRYK  
2002 Archaeology in the Kuril Islands: Advances in the study of human paleobiogeography and northwest Pacific prehistory. *Arctic Anthropology* 39(1–2):69–94.
- FITZHUGH, W. W.  
1999 Ainu ethnicity: A history, in *Ainu: Spirit of a Northern People*: 9–26, ed. W. W. Fitzhugh and C. O. Dubreuil. Washington, D.C.: Smithsonian Institution Press.
- HUBERTY, C. J.  
1994 *Applied Discriminant Analysis*. New York: Wiley & Sons.
- GOLUBEV, V. A.  
1972 Archaeology of the Kuril Islands. Ph.D. diss. (Avtoreferat of the dissertation on competition of a scientific degree of the candidate of historical sciences), ed. A. P. Okladnikov. Separate print. Novosibirsk (in Russian).
- GOLUBEV, V. A., AND E. L. LAVROV  
1988 *Sakhalin in the Stone Age*. Novosibirsk: Nauka (in Russian).
- GORSHKOV, G. S.  
1970 *Volcanism and the Upper Mantle*. New York: Plenum Press.
- GRAYSON, D. K.  
1984 *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas*. New York: Academic Press.
- HANSKI, I.  
1986 Population dynamics of shrews on small islands accord with the equilibrium model. *Biological Journal of the Linnean Society* 28:23–36.
- HASEGAWA, T.  
1998 *The Northern Territories Dispute and Russo-Japanese Relations*. Berkeley: University of California, International and Area Studies.
- HILDEBRANDT, W. R., AND T. L. JONES  
1992 Evolution of marine mammal hunting: a view from the California and Oregon coasts. *Journal of Anthropological Archaeology* 11:360–401.
- HOAGLIN, D. C., F. MOSTELLER, AND J. W. TUKEY  
1983 *Understanding Robust and Exploratory Data Analysis*. New York: Wiley & Sons.
- IMAMURA, K.  
1996 *Prehistoric Japan: New Perspectives on Insular East Asia*. London: UCL Press.
- ISHIZUKA, Y., B. FITZHUGH, AND M. NAKAGAWA  
2001 Volcanic activity and recent tephra in the Kuril Islands: Field results during the International Kuril Island Project (IKIP). Poster presented at the International Symposium on Kuril Island Biogeography. 19–22 May 2001. University of Hokkaido, Sapporo.
- KAPLAN, H., AND K. HILL  
1992 The evolutionary ecology of food acquisition, in *Evolutionary Ecology and Human Behavior*: 167–201, ed. E. A. Smith and B. Winterhalder. New York: Aldine de Gruyter.
- KIKUCHI, T.  
1999 Ainu ties with ancient cultures of Northeast Asia, in *Ainu: Spirit of a Northern People*: 47–51, ed. W. W. Fitzhugh and C. O. Dubreuil. Washington, D.C.: Smithsonian Institution Press.
- KIRCH, P. V.  
1988 Long-distance exchange and island colonization: The Lapita case. *Norwegian Archaeological Review* 21(2):103–117.  
1997 Microcosmic histories: Island perspectives on “global” change. *American Anthropologist* 99(1):30–42.
- KIRCH, P. V., AND J. ELLISON  
1994 Palaeoenvironmental evidence for human colonization of remote Oceanic islands. *Antiquity* 68(259):310–321.

KNECHT, R. A., AND R. S. DAVIS

- 2001 A prehistoric sequence for the eastern Aleutian Islands, in *Archaeology in the Aleut Zone: Some Recent Research*: 269–288, ed. Don E. Dumond. University of Oregon Anthropological Papers No. 58. Eugene: University of Oregon Press.

KODAMA, S.

- 1948 *Moyoro Shell Mound*. Sapporo: Hokkaido Genshi Bunka Kenkyukai Shuppan-bu (in Japanese).

KOSTENKO, V. A.

- 2000 *Rodents (Rodentia) of the Russian Far East*. Vladivostok: Institute of Biology and Soil Sciences, Russian Academy of Sciences, Far East Branch, Dalnauka.  
2002 The terrestrial mammals, in *Flora and Fauna of the Kuril Islands: Results of the International Kuril Island Project*: 135–143, ed. S. Yu Storozhenko, V. V. Bogatov, and A. S. Lelej. Vladivostok: Dalnauka (in Russian).

KRASHENINNIKOV, S. P.

- 1972 *Explorations of Kamchatka, 1735–1741*, trans. E.A.P. Crownhart-Vaughan. Portland: Oregon Historical Society.

KUZMIN, Y. V., S. V. ALKIN, A. ONO, H. SATO, T. SAKAKI, S. MATSUMOTO, K. ORIMO, AND S. ITO

- 1998 *Radiocarbon Chronology of the Stone Age of Northeast Asia*. Vladivostok: Pacific Institute of Geography.

KUZMIN, Y. V., M. D. GLASCOCK, AND H. SATO

- 2002 Sources of archaeological obsidian on Sakhalin Island (Russian Far East). *Journal of Archaeological Science* 29:41–49.

LEBEDINTSEV, A. I.

- 1990 *Early Maritime Cultures of Northwestern Priokhot'e*. Leningrad: Nauka (translated to English by R. Bland and re-published by the U.S. National Park Service in 2000).  
1998 Maritime cultures of the north coast of the Sea of Okhotsk. *Arctic Anthropology* 35(1): 296–320.

LYMAN, R. L.

- 1995 On the evolution of marine mammal hunting on the west coast of North America. *Journal of Anthropological Archaeology* 14(1):45–77.

MACARTHUR, R. H., AND E. O. WILSON

- 1967 *The Theory of Island Biogeography*. Princeton: Princeton University Press.

MADSEN, D. B., AND D. N. SCHMIDT

- 1998 Mass collecting and the diet breadth model: A Great Basin example. *Journal of Archaeological Science* 25(5):445–455.

MCGOVERN, T. H.

- 1990 Archaeology of the Norse North Atlantic. *Annual Review of Anthropology* 19:331–351.

MORROW, T. A.

- 1997 Chip off the old block: Alternative approaches to debitage analysis. *Lithic Technology* 22(1):51–69.

NATORI, T.

- 1948 *The Moyoro Site and Archaeology*. Sapporo: Kodansha (in Japanese).

NAZARKIN, M. V., AND A. I. LEBEDINTSEV

- 1993 Fish remains from early sites of the north coast of the Sea of Okhotsk. *Voprosy ikhtiologii* 33(4):193–198 (in Russian).

NIIMI, M.

- 1994 Sea mammal hunting in northern Japan during the Jomon period. *ArchaeoZoologia* 6:37–56.

NISHIMOTO, T.

- 1978 The subsistence of Okhotsk culture—a reconstruction of food supply from faunal remains. *Material Culture* 31:1–12 (in Japanese).  
1984 The hunting and fishing activities of the Jomon and Epi-Jomon culture—an analysis of the faunal remains. *Bulletin of the National Museum of Japanese History* 4:1–15 (in Japanese with English summary).

- OKADA, A.  
1998 Maritime adaptations in Hokkaido. *Arctic Anthropology* 35(1):340–349.
- OKADA, H.  
1998 Maritime adaptations in northern Japan. *Arctic Anthropology* 35(1):335–339.
- OTAISHI, N.  
1994 Okhotsk culture: Prehistoric hunting and fishing reconstructed from the Sea of Okhotsk paleofauna. *ArchaeoZoologia* 6(2):71–78.
- PIETSCH, T. W., K. AMAOKA, D. E. STEVENSON, E. L. MACDONALD, B. K. URBAIN, AND J. A. LOPEZ  
2001 Freshwater fishes of the Kuril Islands and adjacent regions. *Species Diversity* 6(2):133–164.
- PIETSCH, T. W., V. V. BOGATOV, K. AMAOKA, Y. N. ZHURAVLEV, V. Y. BARKALOV, S. GAGE, H. I. TAKAHASHI, A. S. LELEJ, S. Y. STOROZHENKO, N. MINAKAWA, D. J. BENNETT, T. R. ANDERSON, M. ÔHARA, L. A. PROZOROVA, Y. KUWAHARA, S. K. KHOLIN, M. YABE, D. E. STEVENSON, AND E. L. MACDONALD  
2003 Biodiversity and biogeography of the islands of the Kuril Archipelago. *Journal of Biogeography*.
- SAITÔ, H.  
1938 Report on the dog bones from pit-dwelling sites and shell-mounds in Kuril Islands and Sakhalin. *Minzokugaku-kenkyu* 4(4):85–106.
- SALTONSTALL, P., AND G. A. CARVER  
2002 Earthquakes, subsidence, prehistoric site attrition and the archaeological record: A view from the Settlement Point site, Kodiak Archipelago, Alaska, in *Natural Disasters and Cultural Change*: 172–192, ed. R. Torrence and J. Grattan. *One World Archaeology* 45. New York: Routledge.
- SASAKI, S.  
1999 Trading brokers and partners with China, Russia, and Japan, in *Ainu: Spirit of a Northern People*: 86–91, ed. W. W. Fitzhugh and C. O. Dubreuil. Washington, D.C.: Smithsonian Institution Press.
- SHUBIN, V. O.  
1977 First non-ceramic artifacts from Sakhalin and Kuril Islands, in *Archaeological Investigations in the Sakhalin Region*, ed. R. S. Vasil'evskii. Vladivostok: Akademii Nauk, USSR, DVNC (FEB) (in Russian).  
1990 Development of archaeology of Sakhalin and Kuril Islands: Modern condition and prospects—looking to the future: 53–54. Abstracts, Seventh Inuit Studies Conference. Fairbanks: University of Alaska.  
1994 Aleut in the Kuril Islands, in *Anthropology of the North Pacific Rim*: 337–345, ed. W. W. Fitzhugh and V. Chaussonet. Washington, D.C.: Smithsonian Institution Press.
- STASHENKO, T. V., AND S. A. GLADYSHEV  
1977 Ancient monuments of the Kuril Islands, in *Archaeological Investigations in the Sakhalin Region*, ed. R. S. Vasil'evskii. Vladivostok (in Russian).
- STUIVER, M., P. J. REIMER, E. BARD, J. W. BECK, G. S. BURR, K.A.H., BERND KROMER, F. G. MCCORMAC, J. VAN DER PLICHT, AND M. SPURK  
1998 INTCAL98 radiocarbon age calibration 24,000–0 cal B.P. *Radiocarbon* 40:1041–1083.
- STEPHENS, D. W., AND J. R. KREBS  
1986 *Foraging Theory*. Princeton: Princeton University Press.
- SULLIVAN III, A. P., AND K. C. ROSEN  
1985 Debitage analysis and archaeological interpretation. *American Antiquity* 50:755–779.
- TERRELL, J. E.  
1977 Biology, biogeography and man. *World Archaeology* 8:237–248.  
1997 Postponed agenda: Archaeology and human biogeography in the twenty-first century. *Human Ecology* 25:419–436.
- TIKHMENEV, P. A.  
1978 *A History of the Russian-American Company*, ed., trans. R. A. Pierce and A. S. Donnelly. Seattle: University of Washington Press.
- USHIRO, H.  
1996 Archaeological materials collected from Kuril Islands—collection of Mataroku Nagao, in *The Memoirs of the Preparative Office*: 71–90. Nemuro: Nemuro Municipal Museum 10 (in Japanese).

- VASIL'EVSKII, A. A.  
 1992 Neolithic cultures of Sakhalin Island. *Hokkaido Kokugaku* 28:115–136.  
 1995 Calibrated radiocarbon dates and archaeological chronology of the Sakhalin cultures. *Obshchestvo Izucheniia Sakhalina i Kuril'ski Ostrova* 2:93–110.  
 1997 Archaeological sites of the Lutoga Valley and their importance to the study of Far East Paleolithic, in *Problemi Arkheologii Kamennogo Veka*: 107–125, ed. A. M. Kuznetsov. Ussuriisk: Ussuriiskii Gostudardarstvennyi Pedagogicheskii Institut.
- VASIL'EVSKII, R. S., AND B. A. GOLUBEV  
 1976 *Ancient Settlements on Sakhalin: Sosuya Site*. Novosibirsk: Nauka (in Russian).
- VELTRE, D. W.  
 1998 Prehistoric maritime adaptations in the western and central Aleutian Islands, Alaska. *Arctic Anthropology* 35(1):223–233.
- WALKER, B. L.  
 2001 *The Conquest of Ainu Lands: Ecology and Culture in Japanese Expansion, 1590–1800*. Berkeley: University of California Press.
- WANTANABE, H.  
 1972 *The Ainu Ecosystem: Environment and Group Structure*. Seattle: University of Washington Press.
- WHITTAKER, R. J.  
 1998 *Island Biogeography: Ecology Evolution and Conservation*. Oxford: Oxford University Press.
- WOBST, H. M.  
 1974 Boundary conditions for Paleolithic social systems: A simulation approach. *American Antiquity* 39(2):147–178.
- WORKMAN, W. B.  
 1979 The significance of volcanism in the prehistory of Subarctic Northwest North America, in *Volcanic Activity and Human Ecology*: 339–371, ed. P. Sheets and D. K. Grayson. New York: Academic Press.
- YAMADA, G.  
 1999 The distribution of the archaeological sites and environmental human adaptation in the Kuril Islands, in *Peoples and Cultures in the Northern Islands: Proceedings of the 10th International Abashiri Symposium*: 1–18. Abashiri: Hokkaido Museum of Northern Peoples.
- YAMADA, G., AND T. KAORU  
 1992 Pollen analysis of the plants and marshy sediments distributed on the coast of Aleutka Bay, Urup Island, in *Preliminary Reports on "Research Projects of the Historical and Cultural Exchange of the North" in 1991*: 61–78. Sapporo: Historical Museum of Hokkaido.
- YAMAURA, K.  
 1998 The sea mammal hunting cultures of the Okhotsk Sea with special reference to Hokkaido prehistory. *Arctic Anthropology* 35:321–334.
- YAMAURA, K., AND U. HIROSHI  
 1999 Prehistoric Hokkaido and Ainu origins, in *Ainu: Spirit of a Northern People*: 39–46, ed. W. W. Fitzhugh and C. O. Dubreuil. Washington, D.C.: Smithsonian Institution Press.
- YESNER, D. R.  
 1980 Maritime hunter-gatherers: Ecology and prehistory. *Current Anthropology* 21:727–750.  
 1998 Origins and development of maritime adaptations in the Northwest Pacific region on North America: A zooarchaeological perspective. *Arctic Anthropology* 35(1):204–222.
- ZAITSOVA, D. I., S. G. POPOV, A. P. KRYLOV, Y. V. KNOROZOV, AND A. B. SPEVAKOVSKIY  
 1993 Radiocarbon chronology of archaeological sites of the Kurile islands. *Radiocarbon* 35:507–510.
- ZAYAKIN, Y. A., AND A. A. LUCHININA  
 1987 *Catalogue of Tsunami on Kamchatka*. Vniigmi-Mtsd, Obninsk, Russia (in Russian).

#### ABSTRACT

This article presents analyses of lithic and zooarchaeological data from the Kuril Islands and Sakhalin Island in the Russian Far East to better understand the effects of

island isolation and biodiversity on human settlement and subsistence. Using the theory of island biogeography, we examine predictions about lithic raw material use, trade, mobility, and foraging behavior for different island groups. This study finds convincing evidence that insularity imposed significant constraints on prehistoric maritime hunter-gatherer access to lithic raw materials and foraging targets in this part of the North Pacific. We find that lithic raw materials are constrained in their distribution and conserved in more insular areas, while zooarchaeological taxonomic composition and richness data pattern according to expectations from optimal foraging theory applied across islands of variable biogeographic diversity. While based on limited samples, the results of these analyses provide support for a biogeographical approach to the prehistory of islands and add to our understanding of human adaptation in the Sea of Okhotsk. **KEYWORDS:** island biogeography, Kuril Islands, lithic analysis, maritime hunter-gatherers, North Pacific Rim, Sakhalin, Sea of Okhotsk, zooarchaeology.